

Length of ear 9"; widest part  $7\frac{1}{2}$ ".

Hind-leg level with the point where the loose skin joins the belly (as before) 18".

Widest part of body (as before) 46".

Narrowest part of body in front of hind-legs  $38\frac{1}{2}$ ".

These dimensions indicate animals rather larger than Sumatran Serows; and in some degree justify Mr. Henry's statement as to the Chinese animal being as large as a cow.

In my opinion, Mr. Brooke's specimens fully justify the recognition of *Nemorhædus argyrochetes* as a valid species, especially as it appears to inhabit the same district as *N. milne-edwardsi*. The ears of the White-maned species appear to be rather larger than those of the other.

Mr. Brooke mentions that the White-maned Serow is known to the natives as "Nikka" and the dark species as "Nik-lu."

The Sze-chuen race of the true Serow has the back black mingled with white; the front of the fore-legs is black to the knees, below which the limb is grey with patches of rusty; the hips and posterior surfaces of the hind-limbs are rufous, the black on the front surface extending some distance short of the hocks. These particulars are taken from a mounted skin presented by Mr. Brooke to the Museum.

I may add that I have given a preliminary notice of the specimens forming the subject of this paper in the 'Field' for October 8th, 1908.

5. Warning Coloration in the Musteline Carnivora\*. By R. I. Pocock, F.L.S., F.Z.S., Superintendent of the Zoological Society's Gardens.

[Received December 15, 1908.]

(Text-figures 193-198.)

As long ago as 1846, Hamilton Smith wrote: "The Ratels offer one more instance of the colours of the fur being light on the upper surface of the body and dark beneath, producing a kind of family livery, alike in this and the Grisons, *Taxidea* and *Meles*, and not obliterated in *Eira* [*Galera*] and *Arctonyx*."† The circumstance in fact is so well known that it would be profitless to search literature for earlier and even later records. Some later authors indeed have drawn attention to the style of coloration above described as being uncommon and as a "divergence

\* Under the term Musteline I include in this paper both Weasel-like and Badger-like Carnivora, which are generally referred to two distinct subfamilies, Mustelinæ and Melinæ. I have not aimed at making the list of nauseous species complete; but have based my conclusions in the main upon those which have come, as living animals, directly under my own observation.

† Jardine's Nat. Library, xv. Mammalia, pp. 205-206.

from the usual rule"\*; and Mr. Lydekker observes: "It is also noteworthy that in the parti-coloured examples [of the Mustelidæ] there is a great tendency for the underparts of the body to be darker than the upper; whereas, it is scarcely necessary to observe, the reverse is the case in the great majority of mammals."†

Before the publication of Mr. Thayer's paper explaining the relative or procryptic significance of the usual style of coloration whereby reflected lights are toned down and shadows obliterated, it was hardly to be expected that any special inquiry would be made as to the meaning of the peculiar livery of the Mustelines in question; but, so far as I am aware, no suggestion has been made on this head since the publication of that luminous idea‡. Yet the inference seems obvious enough that, since the colours are reversed, their functions must also be reversed; that is to say, if animals which are light below and dark above are concealed on this account under a top light in their normal surroundings, those which are light above and dark below should be made conspicuous under the same conditions. White on the upper side should have the effect of enhancing reflected light, and dark on the under side the effect of emphasising shadows.

A simple experiment demonstrates this to be a fact. If a cork be pinned with a long pin against a sheet of brown paper of its own colour under a top light, it may be made practically invisible, as Thayer has shown, by painting its upper side dark and its under side white. But if the cork be then turned over so that its white side be uppermost and its dark side undermost, its maximum of conspicuousness is achieved. The effect of turning it over is much the same as that produced by immensely increasing the intensity of the top light over the uncoloured cork.

In the case of Mammalia, it is exceptional for the coloration to be of a kind that makes for conspicuousness. In the majority of instances it is procryptic for the purpose of enabling the individual either to escape enemies or to secure prey. Hence, if it be claimed that the livery of these Mustelines belongs, as I think, to the former category, it is necessary to produce in favour of the claim evidence drawn from the bionomics of the species in addition to that deducible from the above mentioned fact that the coloration is the very opposite of that exhibited by a very large number of procryptically coloured forms. Sufficient evidence to justify the adoption of this view as a useful working hypothesis, is, in my opinion, supplied by what is known of the habits of the species discussed in the following pages.

With the exception of mimetic species, animals which are coloured so as to be conspicuous in their natural surroundings are very often protected from enemies by distastefulness arising from a nauseating flavour or odour, or by the possession of poison-

\* J. G. Wood, 'Illustrated Nat. History,' Mammalia, p. 372, 1861.

† Royal Natural History, ii. p. 47, 1894.

‡ 'The Auk,' xiii. 1896, pp. 124 & 318.

glands and stings which make them dangerous to meddle with. They also as a very general rule have no need of procryptic coloration to enable them to capture wary or keen-sensed prey. Their movements are usually slow and deliberate, and instead of avoiding they seem rather to court observation, some indeed attracting attention by the emission of characteristic sounds. Very commonly also they are hard, tough, and difficult to kill.

Porcupines of the genus *Hystrix* furnish a good instance of this. Protected by their spine-armature, they are quite conspicuous in the dusk by reason of the predominance of white on the dorsal surface, and they make themselves heard by shaking their caudal rattles and uttering hoarse grunts. This I pointed out last year (see P. Z. S. 1906, p. 902, pubd. April 1907). Subsequently I noticed that the Canadian Tree-Porcupine (*Erethizon*), which which has no rattle, but is conspicuously coloured when its spines are erected, possesses a strong and unpleasant odour recalling that of concentrated human perspiration. This is also very possibly one of the aposematic attributes of the species; and I have recently come across a passage showing that exactly the same discovery was made about forty years ago by that keen naturalist Charles Kingsley in connection with the Brazilian Tree-Porcupine or Coendoo (*Coendu*). He wrote: "More than once we became aware of a keen and dreadful scent, as of a concentrated essence of unwashed tropic humanity, which proceeded from that strange animal, the Porcupine with a prehensile tail, who prowls in the tree-tops all night, and sleeps in them all day, spending his idle hours in making this hideous smell. Probably he or his ancestors have found it pay as a protection; for no Jaguar or Tiger-cat, it is to be presumed, would care to meddle with any thing so exquisitely nasty, especially when it is all over sharp prickles."\* It is interesting that the same comparison should have been independently employed both by Kingsley and myself in attempting to describe the scent of these Porcupines; and that he should have anticipated me by so many years in assigning a protective value to it.

Up to the present time the only Mammals, apart from Porcupines, claimed to be warningly coloured, so far as I am aware, are the Skunks of America (*Mephitis*, *Conepatus*, *Spilogale*) and the Zorillas of Africa belonging to the genus *Ictonyx* and known in Cape Colony as Cape Polecats. These are black Mustelines ornamented dorsally, as a rule, with broad clear white longitudinal stripes, which sometimes coalesce or almost coalesce to form a continuous white field. When attacked they increase their apparent size and enhance their conspicuousness by erecting the long hairs of their bodies and by brandishing their bushy white tails. At the same time they eject from their anal glands a volatile fluid, with a most repulsive, acrid and persistent odour. Skunks in captivity are frequently quiet undemonstrative animals;

\* 'At Last,' p. 248, ed. 3, 1805; quoted also by J. G. Wood in Waterton's Wanderings in South America, p. 458, MacMillan & Co., 1879.

but I have seen a Cape Polecat behave in the way described above at the sight of a small dog, uttering the while shrill squeals of anger. Both Skunks and Cape Polecats are said to feed naturally upon any small terrestrial vertebrates they can catch, and also upon insects. Merriam indeed describes the North-American Skunk as preeminently an insect-eater, adding that it "destroys more beetles, grasshoppers, and the like, than all our other mammals together," also "he devours vast numbers of mice." But those that have come under my observation in the Zoological Gardens will eat fruits like bananas and dates. Hence they are in all probability omnivorous in their native haunts; and are, therefore, not dependent for food upon the live things they capture.

Text-fig. 193.



Cape Zorilla (*Ictonyx capensis*), left-hand figure, and Cape Weasel (*Pæcilogale albinucha*), right-hand figure.

I have been able to demonstrate experimentally and to my complete satisfaction, that the white on Skunks and Zorillas makes them conspicuous at night, whether it be cloudy or starlit, against the dark background of the soil or of low herbage. I made the experiment with three stuffed skins, one of the Canadian Skunk (*Mephitis mephitis*), one of the Cape Zorilla (*Ictonyx capensis*), and one of the Libyan Zorilla (*Ictonyx libyca*). The Skunk was not a good specimen, having died in bad coat with short hair, yet I could see it at a distance of 15 feet. The others were easily visible at twice that distance\*, the Libyan Zorilla being more visible than the Cape specimen on account of the greater amount of white on its dorsal area. The conspicuousness of all three was enhanced when they were made to move. On the other hand, when put upon the snow

\* They would clearly be visible at a much greater distance to Carnivora with nocturnal vision.

all are visible, the Skunk being the most conspicuous of the three on account of the greater amount of black in its pelage; and the Libyan Zorilla the least conspicuous for the opposite reason. The interest of this fact lies in the circumstance that the species of Skunk mentioned above frequently has to traverse snow-covered ground; whereas the Libyan Zorilla probably never has to do so. By twilight and daylight the specimens were conspicuous both in vegetation, on the grass, and on snow-covered ground.

Another Weasel which presents a very unusual type of coloration is the genus *Pœcilogale* of tropical and Southern Africa, the typical form of which is *P. albinucha* of Cape Colony. The livery is of the same style as that of *Ictonyx*, the body being black with four snow-white stripes along the back. On the shoulders these coalesce into two stripes which fuse with a large white patch covering the fore part of the nape of the neck and the top of the head. The tail is white. The resemblance between this animal and *Ictonyx* may be an instance of true (Batesian) mimicry as Mr. Lydekker has suggested\*. On the other hand, if *Pœcilogale* is itself protected by an exaggerated development of the sub-caudal stink-glands such as are found in the common weasel, stoat, and polecat, it may be that the similarity in question is an illustration of Müllerian resemblance. Very little seems to be known of the habits of this rare animal, but its long and little form which is typically weasel-like, suggests that it resembles in mode of life the weasel and the stoat, to which it is more nearly related than to the zorillas. If this be so, it would seem that the peculiar style of coloration, so unlike the protective coloration of weasels and stoats, must have either a true warning (aposematic) or a false warning (pseudaposematic) significance.

Another member of this family which I have no doubt is warningly coloured is the Teledu (*Mydaus*) of Indo-Malaya. The general colour is blackish brown, but a white band commonly extends from the top of the head down the spine to the tail, the tip of which is also white. On the back of the head and neck the area of white is increased by the hairs forming a decided erectile crest. This animal, like Skunks and Cape Polecats, is nocturnal. It is slow in its movements and feeds to a great extent upon insects and worms. It also possesses stink-glands, which exude a fetid volatile liquid. According to Horsfield, "the entire neighbourhood of a village is infected by the odour of an irritated Teledu, and in the immediate vicinity of the discharge it is so violent as in some persons to produce syncope," as has been stated to be the case with the discharge of the Skunk. Mr. Shortridge, who has collected these animals in Java, tells me that he believes they feed upon roots; and he has noticed the night air tainted by their smell. I also owe to Mr. Shortridge the suggestion that in Java at all events the Teledu is mimicked

\* Royal Natural History, ii. p. 70, 1894.



by the Ferret-Badger (*Helictis orientalis*). There is unquestionably a close superficial resemblance between them in size, form, and colour, although the white on the nape and shoulders of *Helictis* is less extensive and there is more white on the face than in *Mydaus*. *Helictis*, however, may be itself a protected form, and in this case the resemblance between it and *Mydaus* is probably an instance of common warning coloration usually called Müllerian mimicry.

Text-fig. 194.



Teledu (*Mydaus javanensis*), upper figure, and Ferret-Badger (*Helictis orientalis*), lower figure.

In the genera of Mustelidæ above described the coloration is very specialised, consisting in the Skunks and Zorillas of alternating black and white bands, and in the Teledus and Ferret-Badgers of a single white band running down the back. There are some Skunks, however, in which the entire dorsal area is white, as if the white stripes had extended towards the middle line and coalesced. It is quite possible, however, that the uniform whiteness of the back is the more primitive livery of the two, and that the ancestral Skunk was grey-backed, like a Ratel, later forms becoming white-backed by the gradual whitening of the whole dorsal area, or striped by the sorting of the hairs into black and white bands.

One of the best-known examples of the style of coloration mentioned above, in which the upper side is markedly lighter than the under, is the Ratel (*Mellivora*), which is represented by species or subspecies in India, Arabia, and Africa. The back and head, sometimes white, as a rule are iron-grey, the muzzle, legs, and under side being jet-black. Where the grey or white of the dorsal surface meets the black of the under surface, the contrast between the two is emphasised by a whiter line which is very

conspicuous both on the forehead and the sides of the body. One form only is black above as well as below.

There is abundant testimony to the unpleasantness of the odour emitted by Ratels. Writing of the Cape Ratel, Mr. W. L. Sclater says: "It further defends itself by emitting an offensive odour from its anal glands."\* In his account of the habits of the Indian species, Blanford does not mention this attribute; but I have been told by Indian sportsmen that the characteristic is well known, and two of the Society's keepers, Dixon and Hoare, who have looked after a male specimen that is still living in the Gardens, tell me that formerly this animal, when threatened or disturbed, would emit an odour, described as suffocating, which could be perceived at a distance, varying according to the estimate of the raconteur, from fifty to one hundred yards.

Text-fig. 195.



White-backed Ratel (*Mellivora ratel*).

Ratels are omnivorous, and can be kept in confinement in health and strength without meat. Their liking for honey is notorious, and is the attribute from which their generic name has been derived. They are known to be desperate fighters and extraordinarily tenacious of life. The skin is not only very thick, but also very loose, so that if seized by almost any part of it the animal can reach and bite its assailant. Of the African species Mr. Sclater says: "It is very difficult to kill, only, it is said, by actually crushing its skull or by stabbing to the heart can this be effected." The very small size of the ears in the Ratel is another noticeable feature bearing on the question of his immunity from attack. Animals which require sharp hearing either to escape enemies or capture prey usually at all events have large ears; and the fact that the animals forming the subject matter of this

\* 'The Mammals of South Africa,' i. p. 112, 1900.

paper have small external ears is in keeping with the theory that they have no enemies to fear.

Caged Ratsels do not always make use of their scent-glands. For example, two specimens of *M. capensis* in the Society's Gardens never did so; and the keeper in charge, noticing this difference in behaviour between them and the specimen of *M. indica* above mentioned, asked me if it was a specific feature. The explanation no doubt is that when once tamed these animals soon learn that they are safe from enemies, and therefore do not resort to this special mode of defence.

The coloration of the Grison (*Grison furax* = *Galictis vittata*), a South-American musteline, is very similar to that of the Ratel (*Mellivora*). The whole of the upper side of the head and body is greyish, the under side of the body and head and the limbs being black. Across the forehead and along each side of the head towards the shoulder at the junction of the grey and black, there runs a whitish band which is very conspicuous as the animal advances.

I have the independent testimony of two of the Society's keepers, Dixon and Heffer, that when Grisons fight or are disturbed they stink like Skunks and Cape Polecats (*Ictonyx*); and J. G. Wood\*, writing apparently of his own knowledge, says: "The odour which proceeds from the scent-glands of the Grison is peculiarly disgusting, and offends human nostrils even more than that of the stoat and polecat." The Grison also has the reputation of being extremely savage and a most dangerous foe to any animal it ventures to attack. It was of this species, and probably the next, that Mr. W. H. Hudson wrote ". . . there are [on the pampas of La Plata] two quaint-looking weasels, intensely black in colour, and grey on the back and flat crown. One, the *Grison furax*, is a large bold animal that hunts in companies; and when these long-bodied creatures sit up erect, glaring with beady eyes, grinning and chattering at the passer by, they look like little friars in black robes and grey cowls; but the expression on their round faces is malignant and bloodthirsty beyond anything in nature, and it would perhaps be more decent to liken them to devils rather than to humans"; and again: "After watching the weasels dance for some minutes, I stepped up to the mound, whereupon the animals became alarmed and rushed pell-mell into the burrows, but only to reappear in a few seconds, thrusting up their long ebony-black necks and flat grey-capped heads, snarling and chattering at me, glaring with fierce beady eyes." The same author bears testimony to the absence of the hiding instinct in the young of this species. He says: "I once surprised a weasel [*Grison furax*] in the act of removing her young, or conducting them, rather; and when she was forced to quit them, although still keeping close by, and uttering the most piercing cries of anger and solicitude, the young continued

\* Illustrated Nat. History, i. p. 372.



piteously crying out in their shrill voices and moving about in circles, without making the slightest attempt to escape, or to conceal themselves, as young birds do."\* These passages attest the savage aspect and fearless behaviour of the Grison and the suppression of the instinct to hide in young individuals. These are precisely the attributes one would expect, if the species is specially protected and warningly coloured.

Text-fig. 196.



Grison (*Grison furax*), upper figure, and Patagonian Weasel (*Lyncodon patagonicus*), lower figure.

As is the case with the Ratel and some other mustelines, the

\* 'The Naturalist in La Plata,' pp. 15-16, 104, and 385-386, 4th ed. 1903. In the paragraphs above quoted I have substituted the name *Grison furax* for *Galiotis barbara*. Mr. Hudson's description of the larger animal, apart from his remark that it is "about the size of a cat," coupled with my own knowledge of the geographical distribution of *Galera barbara* and of *Grison furax*, convinced me that he had applied the wrong specific name to the larger La Plata musteline. I therefore wrote to him on the matter, and he kindly confirmed this, adding that he was misled by a wrong label in the Buenos Ayres Museum and had discovered the mistake subsequently. It is important that the error should be corrected, because although obvious enough to those who know the two species under discussion, it has already made its way into the literature of natural history. In the 'Royal Natural History,' for example, the larger of the two weasels mentioned by Mr. Hudson is cited as the Tayra (*Galera barbara*), and the smaller as the Grison (*Grison furax*): whereas the larger is, as stated, the Grison, and the smaller, I suspect, the Patagonian Weasel (*Lyncodon patagonicus*).

diet of Grisons is mixed. Two now living in the Zoological Gardens feed upon fowls' heads, dried dates, and bread and milk.

The so-called Patagonian Weasel (*Lyncodon patagonicus*), although smaller than the Grison, presents much the same style of coloration. The hair of the body and tail is long and grey. On the nape of the neck there is a large black patch which emphasises a large white patch covering the top and sides of the head and extending laterally along the neck. This is set off both in front and below by the black colour of the muzzle, cheeks, sides of the neck, and lower shoulder. The legs are black. Very little seems to be known of the habits of this animal. It may or may not be offensive like the Grison. If it is, its coloration is, I think, probably genuinely aposematic. If it is not, the resemblance in colour between the two may be an instance of true or Batesian mimicry. The evidence, however, that the two species are found together is not conclusive. In favour of this view it may be added that *Lyncodon* has been recorded in Central Argentina from Mendoza and Azul southwards to the Rio Colorado and Rio Negro, and *Grison* also as far south as the Rio Colorado\* ; and according to Trouessart's Catalogue both occur in Northern Patagonia.

But exact coincidence in distribution is not essential to the belief that the resemblance between the two animals is an instance of Batesian mimicry or of Müllerian resemblance. It is merely essential to show that enemies that might prey upon small carnivora of this kind are dispersed over the areas inhabited by the two forms. Wide ranging raptorial birds, for example, that knew the Grison by sight in the northern parts of La Plata, might easily mistake the Patagonian Weasel for the young of it in the southern parts of that country.

An interesting parallel is traceable between *Lyncodon* and *Grison* in South America, on the one hand, and *Pecilogale* and *Ictonyx* in Africa, on the other. In both cases, we have a large musteline which is known to have offensive stink-glands, and a smaller one in which this attribute has not yet been recorded. There are reasons for thinking that in both the larger species the coloration, though widely different, is aposematic; and the smaller form in each case resembles the coloration of its compatriot. The smaller forms also appear to be much scarcer than the larger, a fact which is in favour of their coloration being mimetic.

Singularly enough, too, *Lyncodon* and *Pecilogale* resemble each other and differ from typical mustelines, including their hypothetical models, in the reduction of the number of cheek-teeth to three on each side in both the upper and the lower jaws, the total number of teeth being 28. In both *Ictonyx* and *Grison*, on the contrary, there are four cheek-teeth in the upper jaw and five in the lower, making a total of 34.

\* Matschie, SB. Ges. nat. Fr. Berlin, 1895, p. 190.

Allied to the Grison is another South American musteline, the Tayra (*Galera barbara*). It is a larger animal than the Grison and approaches an otter in size. I cannot find in literature any convincing evidence that this animal stinks to the same nauseating extent as the Grison; but considering the close relationship between the two species, which until lately were referred to the same genus, this must be regarded as probable. Hamilton Smith, however, remarks that it "has a strong musky smell"\*. One that lived a few years ago in the Zoological Gardens was extraordinarily tame, and Dixon, the keeper in charge of it, tells me that it never smelt like the Grisons or Ratels, but only "like a Badger." This negative evidence as to its potential offensiveness

Text-fig. 197.



Bush-Dog (*Speothos venaticus*), upper figure, and Tayra (*Galera barbara*), lower figure.

must not, however, be overvalued; for, as has been explained, two tame specimens of the African Ratel that have recently lived in the Gardens were never known to make use of their stink-glands. The same is true of some Canadian Skunks (*Mephitis mephitis*) we now possess, although their glands are entire; and it is well known that Cape Polecats (*Ictonyx capensis*) can be tamed and kept in houses as pets for destroying rats.

The colour of the Tayra varies, some specimens, perhaps always

\* Jardine's Nat. Library, xv. Mammalia, p. 202, 1868.

young ones, being white, and others black. As a rule, however, they are dark brown or blackish with the head and neck grey, and there seems to be nearly always a conspicuous large yellow patch upon the chest. They eat a variety of food, and one that lived some years in the Zoological Gardens was fed upon dates, bananas, figs, and a little cooked meat. That the Tayra has in a wild state the same savage disposition when attacking or attacked as other mustelines, hardly admits of a doubt; but very little appears to have been recorded of its habits.

Some years ago Mr. O. Thomas pointed out to me the obvious resemblance between *Galera barbara* and the South-American Bush-dog, *Speothos venaticus*; and it occurred to me that it might be mimetic. But I do not at present know enough of the bionomics of the two species, to feel justified in doing more than put forward this view as a theory for future confirmation or refutation. In its favour it may be urged that there are no reasons for supposing that the dog is protected in any way from larger carnivora, and it is apparently much rarer than *Galera*.

A well-known European carnivore with much the same style of body-coloration as the Grison is the Badger (*Meles meles*), which is hoary grey above and black below and on the legs. The coloration of the head, however, is very different from that of the Ratel, Grison, or Tayra, for it is white with a broad black band extending on each side from the muzzle across the eye to the ear, which is itself white-rimmed; and the chin and throat are black.

Badgers are slow and leisurely in their movements, and have earned a reputation for stupidity by the fearlessness and indifference of their manner towards things in general. Their diet is mixed, but they subsist to a very great extent upon vegetable food. In no sense are they dependent for a livelihood, so far as is known, upon the capture of wary mammals or birds. When attacked, they are notoriously most savage and formidable antagonists, being gifted with exceptionally strong jaws, a thick, highly flexible and loose skin, and wonderful tenacity of life. They also possess stink-glands which exude a powerful and unpleasant odour. The scent of the secretion has given rise to the epithet 'stinking brock,' and forms the basis of the well-known simile 'smells like a badger.'

At dusk, when badgers emerge to feed, they are rendered conspicuous by the whiteness of the head; and looking into our badger's cage in the Gardens in the evening, I have often been struck by the ease with which the whereabouts of the animal could be detected, especially when on the move, by the whiteness of this region.

Other species of *Meles* and the Indian Sand-Badger (*Arctonyx collaris*) seem to agree with the European Badger in all respects essential to the present argument in the matter of coloration and mode of life; and the same I suspect is true of the American form, *Taxidea americana*.

A very unusual style of coloration is also presented by the



Sarmatian, mottled or marbled Polecat (*Putorius sarmaticus*). The whole of the upper side of the body is brown variegated with yellowish-white spots and patches, which on the sides of the neck, belly and thighs tend to run into longitudinal stripes, offering a sharp contrast with the jet-black hue of the throat, legs, and the rest of the under side. The tail is long, bushy, and largely white. The head is mostly black, but the lips and chin are white; a broad white band crosses from beneath the ears over the forehead, and the distal half of the ears is white. Blanford remarks of this species, which is found in Eastern Europe and Western Asia, that it has "the same disagreeable fetid odour that

Text-fig. 198.



English Badger (*Meles meles*).

is characteristic of the common [European] Polecat, . . . which is particularly distinguished amongst the weasel tribe for the evil odour generated by the secretion of its anal glands, whence its name of fougart or foul martin."\* He also says that it feeds on birds, rats, mice, lizards, beetles, and snails. The coloration of this animal is so different from that of the ordinary weasels, and conforms in a general way so closely with that of some other fetid members of that tribe, the pattern of the head being especially like that of the Libyan Zorilla (*Ictonyx libycus*), that I cannot help thinking it has a warning significance. Very little, however, seems to be known of this species in its native haunts,

\* Fauna of Brit. India, Mammalia, pp. 163 & 165, 1888.



the information quoted above from Blanford having been taken from Hutton's account based upon observations of living examples in captivity.

Reference was made above to a black form of Ratel. This occurs in the Ituri Forest and was described by Mr. Lydekker as *Mellivora cottoni*\*. This species, or race, has a special interest in connection with the views advocated in this essay, from its bearing upon the theory I have already published †, that where concealment is unneeded animals tend to assume a uniformly dark coloration unrelieved by spots or stripes. As illustrations of this were cited elephants, rhinoceroses, hippopotamuses‡, buffalos, bisons, many bears, moles, ravens, rooks, and others, which, either by their strength and size, their gregarious habits or mode of life, are protected from carnivorous enemies and have no need of procryptic coloration to help them in the capture of prey.

In their habits, many Bears are very similar to badgers and ratels. They are slow and leisurely and bold in their movements, and feed chiefly upon roots, fruits, honey, and other vegetable products, although they will kill and eat living prey. They are not, however, dependent upon it §, as are the Cats, to which they offer the greatest possible contrast both in coloration and mode of life. They have no stink-glands like the Mustelidæ described above, but are well known to be terrible antagonists when fighting. Major Rodon, F.Z.S., has told me that the Himalayan Black Bear (*Ursus torquatus*) is more than a match for leopards, and that he has known one drive a leopard from its kill. Now this species of Bear has a very distinct, somewhat V-shaped white or yellow patch across the chest, which is displayed to full view when the animal stands erect. The Malayan Bear (*Ursus malayanus*) has a similar, usually yellowish, horseshoe-shaped mark; and the Sloth Bear (*Melursus ursinus*) carries the same badge. It is significant that this white mark is shown to an antagonist when the bear assumes its attitude of defence, and it reminds one forcibly of the patch described above possessed by the Tayra (*Galera barbara*); and I venture to suggest that, as in that animal, it acts as a recognition mark and danger signal.

Since the preceding pages were written, I have had the opportunity of discussing with Mr. Abbott H. Thayer the theory of warning coloration in general and its application to Mammalia in particular. Mr. Thayer has already published || his disbelief

\* P. Z. S. 1906, p. 112.

† Pall Mall Magazine, Feb. 1904, pp. 179-180.

‡ It is interesting to record that three young hippopotamuses, one from Nigeria and two from German East Africa, when brought to the Gardens, were pink below and protectively countershaded on Thayer's principle. They were believed to be about two years old at the time. During the two subsequent years, as they grew in size and capability, the under side gradually became pigmented.

§ With exception of the Polar Bears, all the bears in our Gardens thrive on a diet of ship's biscuits and upon the bread and buns given to them by visitors.

|| Trans. Ent. Soc. London, 1903, p. 556.

in warning coloration and his belief that the patterns of nauseous species, to the conspicuousness of which in their natural surroundings several observers have testified, are procryptic. Prof. Poulton has briefly replied to this view so far as butterflies are concerned\*. I will here endeavour to do the same as regards the Mammalia.

As stated in a demonstration given at the Gardens and subsequently in conversation with me, Mr. Thayer holds that the white markings of the Skunk, Badger, Ratel, Teledu, and Grison serve to conceal these animals from the ground-prey upon which they feed. The head of a Badger or Ratel, for instance, would lose its shape when looked at from below, because the white tracts would be cut out against the sky; and this obliteration of identity would be beneficial to the carnivore by enabling him to capture field-mice and other ground-living species. Justification for this hypothesis is found in the demonstrable fact that white spots and patches appear as sky-holes, especially in foliage, when viewed from a lower level; and it may be granted that the markings on the mustelines mentioned above may have the significance claimed for them by Mr. Thayer when they are visible from beneath. But I cannot bring myself to believe that his explanation supplies the key to the guiding factor in their evolution. Take, for example, the Teledu, the food of which is said to consist of insects, larvæ, and worms. It cannot be seriously claimed that the Teledu is helped in getting food of this nature by the whiteness of the top of the head and neck, because worms are blind, whilst nocturnal ground-insects at best have feeble powers of vision. Even if the Teledu feeds also upon mice and other vertebrates with vision something like our own, which must be admitted as a possibility, it is not very obvious how the narrow median white spinal stripe can be of any procryptic use in the way claimed. It would for the most part be invisible to the little animals. It would on the contrary be in full view to an enemy of larger dimensions than the Teledu, especially to one lurking in a tree and looking down upon the musteline passing beneath. So, too, with the Badger. This animal, as has been stated, lives for the most part upon vegetable food, and it is difficult to believe that the catching of mice can have had a survival value in the history of any individuals of sufficient importance to the species to guide the evolution of its facial coloration. On the other hand, it is a demonstrable fact that Badgers grubbing or trotting slowly about in the dusk, as is their wont, are quite conspicuous to human eyes at a distance that could be covered by a wolf's or lynx's spring, simply in virtue of the black and white bandings on the head. It is quite easy to believe, however, that this same pattern must be procryptic against a suitable background of white rocks with black interstices or of foliage with light shafts breaking through, especially if the animal be still; and it is quite

\* 'Essays in Evolution,' 1908, p. 321.

evident that the two explanations are not mutually destructive; but if we have to make a choice between the two, that is to say, between the theory that the coloration of the mustelines mentioned in this paper is aposematic or that it is procryptic, I think the balance of evidence is in favour of the former. We have no experimental proof of either so far as these particular species are concerned. We do not know that any Badgers, or Ratels, or Teledus have escaped destruction by their peculiar coloration; but we are justified in inferring its usefulness to the survival of the species if it has had that effect. So, too, we do not know that any Badgers or Ratels or Teledus have succeeded in capturing living prey in virtue of their peculiar coloration; but if they have done so we are justified in inferring the comparative uselessness of the occurrences to the survival of the species, because these mustelines feed mostly upon food which is insensible to the patterns in question. The fearlessness, fierceness and tenacity of life of these carnivora must also be reckoned with in this connection.

The theory of warning coloration is intimately connected with that of warning sounds. And it is a fact that many poisonous animals like snakes, scorpions, and very large spiders stridulate or rattle, or produce other sounds, when on the defensive or when frightened. It is believed that they advertise themselves by this means and warn their enemies to let them alone. If this be so, and no other explanation has been offered of the fact, we are justified in inferring that advertisement that appeals to the ear is useful to these specially protected species. The bearing of this argument on the likelihood of the occurrence of advertisement that appeals to the eye, is quite obvious.

I will only mention one more fact completely in accord with the aposematic as opposed to the procryptic significance of the coloration of the mammals discussed in this paper. A frightened Skunk or Zorilla with long black and white hairs on end presents exactly the same style of coloration as a common terrestrial Porcupine with black and white quills erected. No one can maintain that the coloration of Porcupines is procryptic for the purpose of capturing prey, because they do not feed upon living animals. And no one who has seen them in the dusk, can dispute that the whiteness of the quills makes them conspicuous. In addition to this they rattle and grunt and stamp, and appear to advertise themselves in all ways at their disposal, and are extremely unpleasant animals to deal with. There seems to me to be no escape from the conclusion that their coloration is aposematic. If so, that of Skunks and Zorillas, with the same style of coloration, and equal though different unpleasantness, is also probably aposematic; and from Skunks and Zorillas we pass to Badgers, Teledus, Ratels, and Grisons; all of which are more or less patterned with white and all gifted with an unpleasant odour.